Enhancing NASA's Procedure Representation Language to Support Planning Operations, Phase II

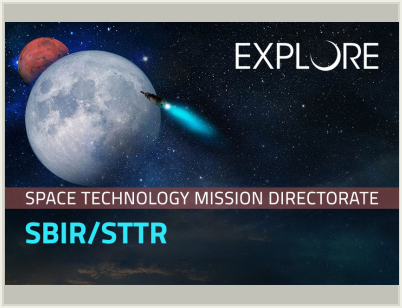
Completed Technology Project (2009 - 2011)

Project Introduction

Automation and autonomy are key elements in realizing the vision for space exploration. The NASA Exploration Technology Development Program (ETDP) has been developing several core autonomy capabilities, one of which is called a procedure representation language (PRL). PRL can be automatically translated into code that can be executed by NASA-developed autonomous executives. Another type of automation being developed by ETDP is automated planning aids. These will be needed to increase the number of missions that existing levels of flight personnel must be able to handle. But PRL has few constructs to enable automated planners and schedulers to take advantage of the procedures resulting from PRL. In Phase 1 we developed extensions to PRL to add planning information resource, constraints and sub-procedural information so as to produce code useable by automated planning software. In this project, we propose to develop an interactive planning aid for flight controllers to show that such an aid can process our enhanced PRL files to generate mission plans and to test their feasibility via an execution system. Besides refining our previous modeling efforts, this work will show that the availability of computer-useable planning information can lead to practical applications of NASA's automated planning efforts.

Anticipated Benefits

The military is currently a large customer for unmanned vehicle operations. Unmanned vehicles, both air and ground, are becoming more common in battlefield situations. In addition, Congress has mandated that one-third of all military vehicles must be unmanned by 2015. As these unmanned vehicles are increasingly deployed in tandem with dismounted forces coordinating software will be necessary to ensure successful operations. Procedures and mission planning play a large role in these kinds of operations. We also see a need for procedures and planning in operations such as refineries, chemical plants, nuclear and other power plants and any installation that has established standard operating procedures that must be carefully followed under often stressful situations, but whose procedures are currently paper, just like NASA's. Moving these industries to electronic procedures tied to system telemetry and integrated with planning will allow for more efficient and safer operations. We expect to tailor PRL and our PRL-related software to these industries and team with existing operators to evaluate and embed our software. Thousands of such facilities exist in the United States alone. Even with a small market penetration, TRACLabs Inc. will have significant revenues to invest in new products and services. Procedures are at the core of all NASA missions, especially human space missions. Mission planning is also at the core of all space missions due to the high cost of space assets such as astronauts, equipment and communication links. Our technologies will have applications across many NASA programs, from Mission Control to on-board NASA vehicles and outposts. We expect applications of our technology to immediately impact NASA's Exploration Technology Development Program



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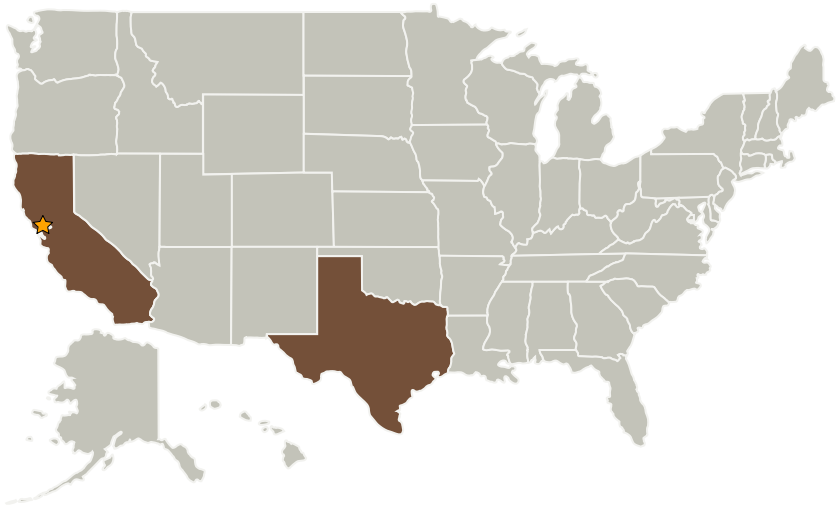
(ETDP). Two areas of ETDP will be immediate beneficiaries of this technology. First, the Centaur robot at NASA JSC is already using a preliminary version of PRL and a simple user interface to allow a remote supervisor to command the Centaur over a communication link. Our work will provide connection to automated planning technologies. Second, the Automation for Operations (A4O) project run out of NASA ARC is using PRL to enhance spacecraft operations. Our PRL extensions and planning technology would also be immediately applicable to spacecraft operations. We will work closely with representatives of both of these projects (Dr. Robert Ambrose at NASA JSC and Dr. Jeremy Frank at NASA ARC respectively) during Phase 1 to ensure our relevance to these two projects.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
TRACLabs, Inc.	Supporting Organization	Industry	Webster, Texas

Primary U.S. Work Locations	
California	Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Manager:

Jeremy D Frank

Principal Investigator:

Russell Bonasso

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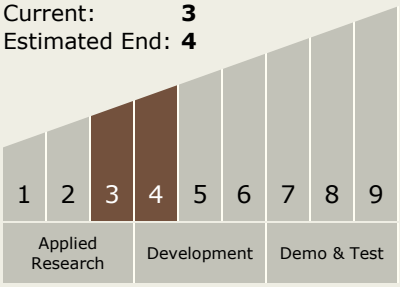
Project Transitions

February 2009: Project Start

February 2011: Closed out

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX10 Autonomous Systems
  - TX10.2 Reasoning and Acting
    - TX10.2.4 Execution and Control